African Chronicles Research Publication Journals p-ISSN 3121-8989, e-ISSN 3121-8970
Onianwa et al. (2026). Afr Chron Res Pub J, 3(3): 1 - 26
Article URL: https://researchpubjournals.org/post.php?post=1588
Public Health research – Supplement 1, Diabetes

Epidemiology of diabetes among people with infertility in Delta North, Delta State Nigeria: Conceptual review

Onianwa I.E[1,2*] Otutu M.O.[1]

[1]Department of Public & Community Health, Novena University Ogume, Nigeria

[2]Medical Department, Federal college of Education Technical Asaba, Delta State, Nigeria.

***Correspondence:** Ifeoma Onianwa, [2]Medical Department, Federal college of Education Technical Asaba, Delta State, Nigeria. Email: evelynifeoma52@gmail.com; Tel: +2348037939102.

Received date: 28th February 2025
Accept date: 26th October 2026
Published: .12th November 2026

Abstract

Background: Diabetes mellitus (DM) is a complex metabolic disorder of the endocrine which manifests with hyperglycemia. DM complication in infertility includes impairment in hormone function, and blood pressure among others.

Objective: To determine the prevalence of diabetes mellitus among people with infertility issues.

Method: This was a traditional literature review. Previous research works on diabetes and infertility were searched on PubMed and Google Scholar. Focus was on the prevalence of DM amongst infertility.

Results: It was found that there is a link between a history of DM and infertility, however, its effect is higher due to its increase in the population being affected worldwide, yet there is not much work done in research on the prevalence and in the complication of DM in relation to infertility. Globally female factor of 35% is responsible for infertility ,45% male factor, 20% for unexplained infertility or combined factor. Nigeria has the prevalence of infertility ranging from 14.5% to 30%. Delta state prevalence of infertility was 32%; infertility can also be seen in up to 40% of women with Diabetes.

Conclusion: DM and infertility are public health problems that affect individual life spam, however adequate glycemic control through life modification and treatment can help one live a normal life and reduce complication thereby reducing infertility. The available data shows that diabetes mellitus affects fertility in both men and female. However, there is still need for further studies.

Keywords; diabetes mellitus, infertility, prevalence, pathogenesis.

African Chronicles Research Publication Journals p-ISSN 3121-8989, e-ISSN 3121-8970
Onianwa et al. (2026). Afr Chron Res Pub J, 3(3): 1 - 26
Article URL: https://researchpubjournals.org/post.php?post=1588
Public Health research – Supplement 1, Diabetes

1: Introduction

1.1: Overview

This work focuses on evaluating the current literature about epidemiology of diabetes mellitus (DM) among individuals with infertility issues. Both diabetes and infertility are among contemporary health problems in society today (Olamoyegun, 2024). This is because of modernization and urbanization which affect the lifestyle and health status of individuals, increasing the risk of non- communicable diseases such as DM (Olamoyegun,2024; Uloko ,2018). The literature is structured into three sections: epidemiology, primary healthcare and health promotion. Each of these sections would consist of conceptual and empirical review. The aim of the study is to know the epidemiology of diabetes mellitus among people with infertility issues.

Diabetes mellitus is a major public health concern worldwide.DM is a group of metabolic disorders having the common feature of hyperglycemia caused by defects in insulin secretion, insulin action, or most commonly both Agarwal, 2024). The disease is due to the disorder of the islet cells of pancreas which produce the insulin hormone that regulates blood glucose level, if not well managed, diabetes mellitus leads to health complications including infertility (Rahman,2021). The review will help to widen the knowledge of diabetes mellitus and its correlation with infertility.

This is the inability to produce offspring, which may result from a problem in either male or the female reproductive system or in many cases, from a combination of problems in both and some causes can be preventable (WHO, 2023). It is not getting pregnant despite having unprotected sex for one year or more. According to WHO, infertility is a disease of a male or female reproductive system defined by the failure to achieve a pregnancy after 12months or more of regular unprotected sexual intercourse (WHO, 2024).

Causes of infertility can include ovulatory disorders due to Polycystic ovary syndrome (PCOS), as a complication of insulin resistance, endometriosis, low sperm count due to low testosterone or azoospermia, many treatment options are available depending on the underlying cause (Carson 2021). However, for this study, our focus is on infertility as one of the complications of diabetes mellitus.

Infertility is a public health problem affecting millions of people with heavy impact on families and communities, WHO estimates suggest that approximately one in every six people of reproductive age worldwide experience infertility in their lifetime (WHO, 2023). It was also stated that in the male reproductive system, infertility is mostly caused by the problems of spermatogenesis which can manifest as oligospermia, azoospermia, abnormal morphology or reduced motility (Leslie 2026).

1.2: Aim of the study

The purpose of this study is to update on some epidemiological concepts of DM in infertility. Specific focus include:

1. Update on pathogenesis of DM
2. Complications of DM
3. Pathogenesis of infertility in DM
4. Epidemiological factors of DM in infertility
5. Prevention and control

1.3: Review method

This followed the traditional review approach with cognizance of SANRA principles. Literatures were obtained from online materials including Google Scholar and PubMed database as well as Our World in Data (OWiD). Literature search in PubMed for epidemiology of DM followed the scoping method about 228,315 articles. Screening for epidemiology of DM among individuals with infertility issues yielded 42 results. With goggle scholar, search for epidemiology of DM showed 2,590,000 results. Out of these articles, 175 results were found on diabetes mellitus and infertility issues.

2. The narrative discourse

2.1: Update on pathogenesis of DM

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia which may be due to impaired insulin secretion and resistance to insulin action (Goyal 2023). Insulin promotes

glucose storage and inhibits its release from the storage (Dimitriadis, 2021). Hyperglycemia is due to insulin insufficiency and/or insulin resistance. It affects carbohydrates, fat and protein metabolism leading to metabolic dysfunction. Due to hyperglycemia, there will be increased utilization of fat and protein leading to release of ketoacids into the plasma which progresses to severe acidosis which can cause diabetic coma and death in the absence of intervention (Hall, 2016).

Hyperglycemia disrupts the normal functioning of multiple organs of the body. This disruption is due to adverse effects of hyperglycemia and the metabolic abnormalities on the normal structure and the functioning of micro- and macro-vasculature (American Diabetes Journal, 2018). The structural and functional disruptions in the organs lead to microvascular and macrovascular complications. Long-term hyperglycemia causes diabetic complications which are mainly associated with diabetes-related morbidity and mortality.

Type I diabetes mellitus, also known as juvenile-onset diabetes, is insulin dependent. It is an autoimmune disease associated with the selective destruction of insulin producing pancreatic β cells. The prompt deficiency of insulin secretion leads to the metabolic disorder. This occurs at a younger age and constitutes about 5-10% of all cases of diabetes (Banday 2020).

DM is chronic health condition with complication that affects the quality of life, it has a rapid prevalence globally and there is possibility of statical increase in a few years (Ojo 2023)

In some cases of children and adolescents affected, the β-cells destruction and subsequent failure occur suddenly which can lead to diabetic ketoacidosis (DKA) while in some, the progression of the disease is slow (Banday 2020). However, in both variables, there is increase in fasting blood glucose level and because of the severe or absolute insulin deficiency, the affected individual depends on insulin treatment for their survival (Banday, 2020) .The presence of IAA in young children who have not been treated previously with insulin is an important indication of developing TIDM, Islets autoantibodies (IAA) are present in about 70% of all infants and young children at the time of diagnosis, at high titers of IAAs, binding the antibodies to insulin prevents or delays the action of insulin, thereby leading to the manifestation of hyperglycemia in the immediate postprandial period (Banday, 2020).

Type 2 diabetes mellitus (T2DM), otherwise known as non-insulin dependent diabetes mellitus (NIDDM), has no evidence of an autoimmune basis, but has an interplay of genetic and environmental factors, it constitutes about 90-95% of all cases of diabetes (Garcia 2020).

One of the key factors in the pathogenesis of diabetes mellitus is insulin resistance which is a condition in which the body's cells do not respond properly to insulin (Freeman 2023). Insulin resistance is often associated with obesity, physical inactivity and unhealthy diet which leads to development of T2DM (Garcia 2020). There are 3 primary benefits of physical activity on the delay of T2 DM onset—skeletal muscle contraction which enhances blood flow into the muscle, increasing uptake of glucose from plasma; it reduces intra-abdominal fat which is a risk factor in insulin resistance; moderate exercise improves glucose uptake by 40%, and increases insulin sensitivity, even reverse inflammation and oxidative stress (Garcia 2020).

During the early stage, decreased insulin sensitivity triggers B-cell in the islets hyperfunction to achieve a compensatory increase in insulin secretion to maintain normal glycemia, hyperinsulinemia thereby prevents hyperglycemia; overtime, the increased insulin secretion by the B cells of the islets in the pancreas will not be able to compensate sufficiently for the decrease in insulin sensitivity which leads to B cells decline in function leading to beta-cell dysfunction and impaired insulin secretion, thereby hyperglycemia develops(Banday 2020).

Another important factor in the pathogenesis of diabetes is genetic predisposition, which involves family history of diabetes (Goyal,2023). Genetic susceptibility contributes to pathogenesis; this was evidenced by the disease concordance rate greater than 90% in monozygotic twins (Wolfs 2009). Genetic factors interact with environmental and lifestyle factors to determine an individual's risk of developing diabetes. For example, individuals with a family history of diabetes may be more susceptible to the disease if they are also overweight and sedentary (Murea, 2012).

In environmental factor, the most important risk factor for T2 DM is obesity which plays a role in the development and progression of T2 DM, can be visceral or central, it affects the regulation of systemic glucose due to its influence on the development of insulin resistance due to its effects on the tissue sensitivity to insulin (Chandrasekaran 2024). In obesity, cells resist insulin, making the

islets produce more to make up in conversion of glucose, this can also cause destruction of the islets. Obesity is an important risk factor for T2DM (Murea, 2012).

Unhealthy eating habits, lack of exercise, increased stress, and environmental factors contribute to the alarming growth of obesity and T2 DM worldwide, this is because obesity causes insulin resistance (Chandrasekaran, 2024. The distribution of fat determines insulin sensitivity which is more likely to be linked with insulin resistance than in peripheral (gluteal/subcutaneous) obesity (Patel, 2013). A sedentary lifestyle is another risk factor. Weight loss through dietary modifications and exercise usually increase insulin sensitivity. Exercise-based intervention is indispensable for diabetic patients (Dong,2019).

A meta-analysis performed in the UK of 1,261,991 people enrolled in 28 cohort studies showed that the risk of T2DM associated with moderate intensity exercise was reduced by 26% with participation in exercise for 150mins/week, by 36% with participation in exercise for 300mins/week and by 53% with participation in exercise for 800mins/week compared with that in individuals who did not exercise (Smith 2016). It is also recommended by the American Diabetes Association that diabetic patients should have at least 150mins of moderate-to-high intensity exercise per week (Colberg, 2010). Exercise can improve the metabolism of glucose and promote the intake of glucose in the blood (Warner 2020). There are different types of DM (Table 1).

Table 1: Types of DM (Banday 2020; Goyal 2023)

Type I Diabetes	Due to autoimmune destruction of β cells in the pancreas leading to insulin deficiency
Type 2 Diabetes	Due to inadequacy in insulin secretion Insulin resistance. Non-insulin dependent.
OTHERS	
Gestational Diabetes	Seen in pregnancy. Diagnosed in the second and third trimester of pregnancy
Diabetes owing to other causes	• Monogenic diabetes syndromes (neonatal DM, maturity-onset diabetes of the young (MODY) • Disease of the exocrine pancreas (cystic fibrosis, pancreatitis, pancreatectomy) • Medication induced (glucocorticoids, HIV/AIDS treatment)

T2 DM is the most common type of DM. It has 4 stages: insulin resistance, prediabetes, T2DM with/ without vascular complications including microvascular and macrovascular Gotwald-Hostalek (2022). Insulin resistance: in this case, the pancreas usually produces sufficient insulin to maintain a normal blood sugar. However, the resistance occurs when the cells resist the insulin thereby occurrence of hyperglycemia.

Prediabetes occurs when the insulin resistance causes increase in blood glucose level above normal. In this stage, the individual still lives normal life; the blood glucose level has not exceeded the diabetic limit (Tabak, 2012). T2DM occurs when the blood glucose level exceeds the limit of normal readings. The function of pancreatic c ells gradually declines before the onset of clinical hyperglycemia (Guo 2023). T2DM progresses slowly and asymptomatically. The clinical manifestations of DM include polyuria, polyphagia, polydipsia, loss of weight, neuropathy, ketonuria, fatigue, blurred vision, infections especially gum, skin and vaginal infections, feeling irritable (Good to know 2020).

T2DM with vascular complications is the last stage which leads to damage in blood vessels, blurred vision, renal dysfunction, cardiovascular dysfunction, sexual dysfunction with low libido which eventually causes infertility (Rask-Madsen, 2013). Damage caused by diabetes mellitus on the microvascular and macrovascular systems are considered the major causes of increased morbidity and mortality in this disease (Carrizzo *et al.,* 2018). Vascular complication due to uncontrolled blood sugar level can lead to poor circulation of blood due to atherosclerosis thereby causing cerebrovascular disease and damage to the feet which can lead to amputation (Liu, 2022). Type 1 diabetes is defined by hyperglycemia due to autoimmune destruction of the insulin-producing beta cells in the pancreas, leading to insulin deficiency and accounts for 5% to10%) of all cases of infertility (Jacobsen, 2026).

Risk factors to T2DM include obesity, aging, genetics, sedentary lifestyle, PCOS, insulin resistance, increase in stress amongst others (Agarwal,2023). Behavioral contributions to the pathogenesis of prediabetes and T2DM include lifestyle behavior which includes dietary intake, lack of exercise, sedentary lifestyle, poor sleeping habits and stress, the relationship between sleep habits and diabetes may be due to the adverse impact on blood glucose regulation and insulin after

decreased sleep duration (Spruijt-Metz 2014). Stress increases T2DM risk by affecting food intake behaviors', mostly causing cravings for and consumption of high caloric foods – high in fat and sugar, thereby increasing postprandial insulin response and obesity associated with increased consumption of unhealthy food (Hill 2022). Stress can also stimulate the hypothalamic-pituitary adrenal to produce cortisol which induces hepatic insulin resistance and decreased insulin secretion (Joseph 2016).

2.2: Complications of DM

The structural and functional disruptions in organ vasculature led to micro and macrovascular complications. These complications are characterized by organ damage, dysfunction and failure. They include-

- Retinopathy: eye related complications which lead to blindness (Chawla, 2016)
- Nephropathy: kidney related complication which can lead to kidney failure if not adequately managed (Chawla,2016).
- Cardiovascular diseases: include increased BP and coronary heart disease congestive heart failure, 20%_30% of patients with acute coronary syndromes have T2 DM (Farmaki 2020).
- Neuropathy: Nerve associated complication which can either be peripheral or autonomic. Gastrointestinal, cardiovascular and genitourinary dysfunctions are autonomic while foot infections including ulcers requiring amputations, osteoarthropathy are of peripheral (American Diabetes Association, 2018).
- Atherosclerotic cardiovascular diseases which consist of cerebrovascular disease, peripheral arterial disease and coronary heart disease commonly occur in DM and as one of the major causes of diabetes associated morbidity and mortality (Tomic 2022).

Microvascular complications of DM include retinal, renal and neuropathic disease. Macrovascular complications include coronary artery and peripheral vascular disease (Islam, 2025). Modification of lifestyle is a primary focus in treatment of insulin resistance; with reduction in calorie and avoidance of carbohydrates that stimulate excessive insulin demand (Freeman 2023).

2.3: Pathogenesis of infertility in DM

Diabetes is a chronic disease that can affect fertility in both male and female (Agbaje,2007; La Vignera 2012). Thus, there is gender differences.

2.3.1: Pathogenesis of infertility in DM among men.

The complications of DM include infertility both on men and women. The effects of DM on the male reproductive system includes: HPG axis dysfunction, ejaculatory disorders, testicular dysfunction, hormonal imbalance, erectile dysfunction (Agbaje 2007). The complex pathophysiological changes caused by high blood glucose level in men include hypothalamic-pituitary gonad axis dysfunction leading to lower serum gonadotrophin and testosterone levels, spermatogenesis and maturation disorders, testicular cell damage, erectile dysfunction (as seen in Fig 1) (Huang 2024). Diabetic patients showed a high risk of subfertility if the glycemic level is not controlled.

Endocrine Dysfunction:

Glucose metabolism is an important factor in spermatogenesis and in cell activity including motility and fertilization ability in sperm (Ding 2015). However, studies have shown that hyperglycemic -induced physiological changes can adversely affect male reproductive hormonal function, particularly through alterations in the hypothalamic -pituitary -gonadal axis (HPG axis) (Hung 2024)

Spermatogenesis is damaged and interstitial cells atrophied. Thus, endocrine dysfunction leads to imbalance in endocrine function in the production of hormones. The hormones produced by this axis Hypothalamic pituitary Gonads (HPG), Follicle stimulating hormone (FSH), Luitenizing (LH) which act on the testis for the production and maturation of sperm cells (Oduwole, 2021).

Defects in Leydig cells decrease serum testosterone levels. Testosterone is responsible for a key role in the production of sperm and maintenance of male fertility; DM also causes damages of the epididymis and has negative impact on sperm motility (La vignera 2012). Low testosterone (hypogonadism) manifestation includes diminished sexual libido, erectile dysfunction, depression and asthenic (lack of energy). DM can impair male reproductive function by affecting the structure and activity of Leydig cells, resulting in reduced testosterone production (He, 2021). Since testosterone plays an essential role in the regulation of spermatogenesis and the maintenance of

male reproductive health, its reduction may negatively affect fertility (La vignera 2012).Furthermore, DM has been associated with histological damage to the epididymis, which may interfere with sperm transport , maturation and motility thereby compromising sperm quality and male fertility(La vignera 2012).Low serum testosterone level associated with several clinical manifestations including diminished sexual libido, erectile dysfunction , depressed mood, fatigue and reduced physical strength (Hackett 2023).

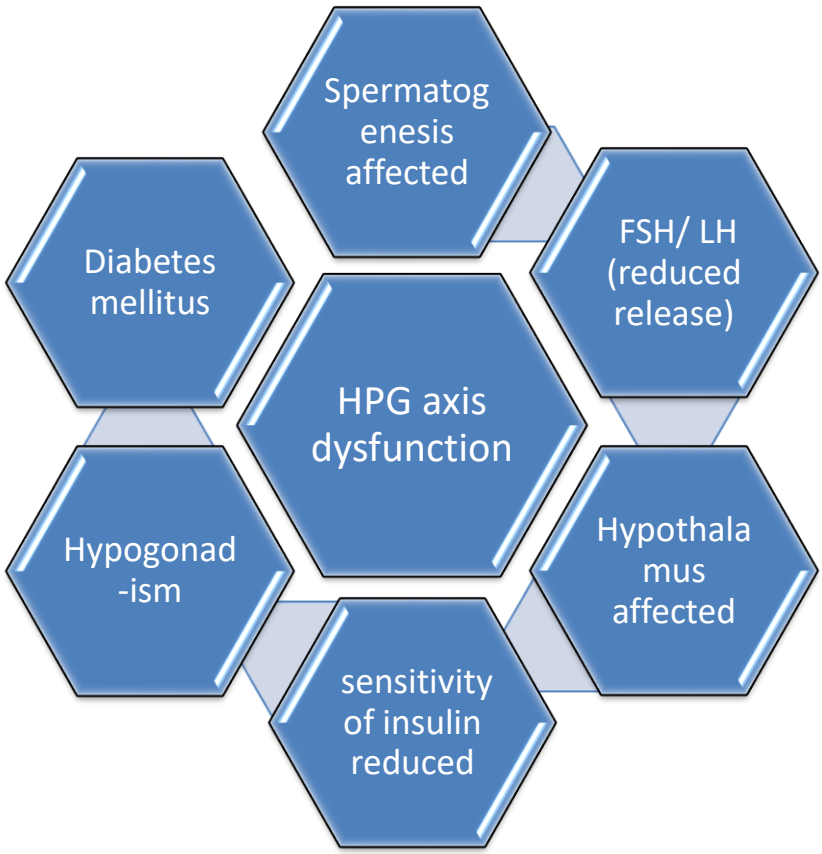


Fig 1: Pathogenesis of infertility in DM in men (Oduwole 2021: Ding 2015).

Testicular Dysfunction:

Diabetes can cause testicular dysfunction in men leading to sperm damages and the microenvironments surrounding the sperm are also affected negatively (Huang 2024).

Pathogenesis of diabetes- induced testicular dysfunction includes Hyperglycemia oxidative stress, apoptosis, disrupted hormone levels (Badejogbin 2024). Insulin deficiency and resistance in diabetes can damage hypothalamus, pituitary gland, gonads, this can lead to the decline in the secretion of sex hormones which includes FSH, LH, testosterone and gonadophin releasing hormone and can lead to testicular atrophy, stromal cell atrophy, seminiferous tubule damage and spermatogenic cell damage (He,2021). These affects male fertility, causing subfertility. Diabetes can affect testicular function, leading to various reproductive issues in men including reduced sperm quality, erectile dysfunction and testicular damage which causes testicular dysfunction leading to infertility; hyperglycemia causes oxidative stress which is the state of imbalance between oxidation (free radical formation) and antioxidant defense in the body, resulting in inflammatory infiltration of neutrophils, increased protease secretion and the production of many oxidative intermediates, leading to tissues oxidative damage (Hung 2024).

Study suggested that in diabetes, oxidative stress causes impaired testicular DNA, survival of reproductive cells, and impaired spermatogenesis leading to male infertility, the damage of oxidative stress also include vasculopathy which leads to microvascular complication, this leads to reduced blood supply (Long 2018). Oxidative stress due to increase blood glucose level damages testicular tissue and sperm. Diabetes, either type1 or type 2 could have detrimental effects on fertility, especially on sperm quality like reduced motility and DNA integrity (Ding G 2015). Diabetes contributes to a decline in global birth rates due to its effects on fertility especially in those societies with a high diabetic prevalence (Maresch 2018).

Erectile dysfunction: This is a situation in which man is consistently unable to get or maintain an erection, caused by damage of nerve (due to hyperglycemia), poor blood circulation (disrupt penile blood flow) thereby affecting sexual erection; Nitric oxide which help to relax the muscles in the penis and increase blood flow is being reduced by hyperglycemia (Burnett 2007). Erectile dysfunction is highly prevalent in men with diabetes (Tamas 2014). It has a multifactorial cause including metabolic, neurologic, vascular, hormonal, psychological compositions example depression and hypertension (as seen in Fig 2) (Hostnik,2025). In a study, it was found out that erectile dysfunction is common in diabetic patients, affecting more than half of men with the

conditions (Kauidrat 2017). It was also found out that physical exercise increases sperm count, motility, also improved testosterone, luteinizing hormone (LH), and follicle stimulating hormone (FSH)level, thereby improving fertility outcome (Lavin-Perez 2021)

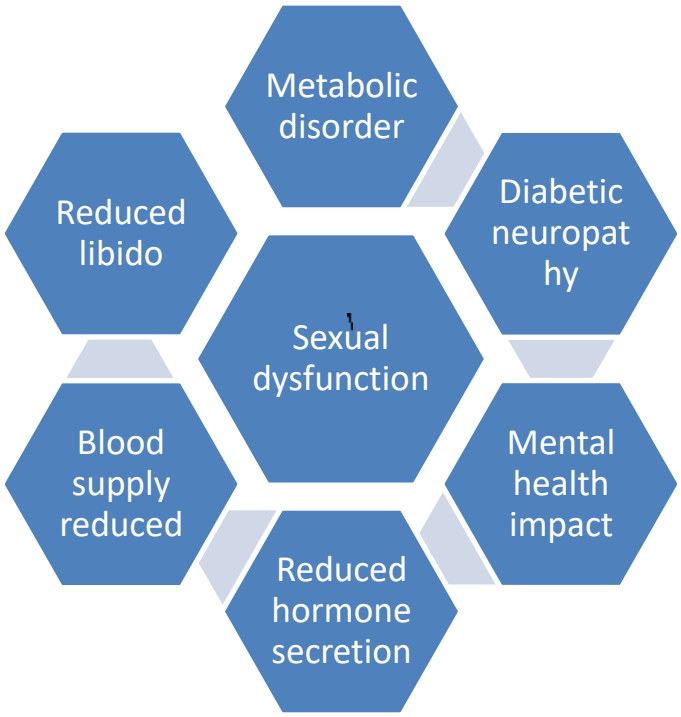


Fig 2: Multifactorial causes of sexual dysfunction (Hostnik 2025)

Pathogenesis of infertility in DM among women

Diabetes mellitus has been associated with reproductive dysfunctions. This is due to its complication on human health. The disorder is seen in up to 40% of women that has diabetes mellitus, it manifests itself in delayed menarche, amenorrhea, menstrual irregularity, menorrhagia, PCOS, early menopause and infertility (Zaimi 2024). Hyperinsulinemia and insulin resistance have impact on the pathogenesis of reproductive dysfunction (Sakumoto, 2010). A high-level insulin can lead to hyperandrogenism and inhibits ovulation, endocrine disruption prompts endocrine dysfunction which manifest itself in hormonal imbalance; also, in IDDM (TYPI) excess use of insulin treatment can promote hyperandrogenism due to hyperinsulinemia which affects the gonadal axis (Fig 3) (Zaimi 2024).

PCOS which is due the hyperandrogenic increase in production of androgen hormones which interferes with the maturation of follicles (egg cells) is one of the endocrine disorders in women of reproductive age (Bernier 2023). Hormonal imbalance in female is associated with metabolic dysregulation which includes hyperinsulinemia and insulin resistance (Ezeh 2022). This manifest in Oligo- ovulation, anovulation in which there is poor maturation of egg cells, thereby causing menstrual irregularities which can be seen in sub fertile woman. In a study 79% of women with PCOS had insulin resistant (Ezeh 2021). In another study, it was also found that according the available data, the Androgen Excess- polycystic ovary syndrome (AE-PCOS) society task force that PCOS should be defined by the presence of hyperandrogenism (clinical and biochemical), ovarian dysfunction (oligo-anovulation and/or polycystic ovaries) (Azziz 2009).

PCOS is an endocrines disorder of reproductive-aged women around the world it affects between 5% - 26% of females worldwide, more than 80% of women who present with hyperandrogenism have PCOS, it also affects above 5 million reproductive aged women in United states (Shukia 2025). Insulin resistance is believed to play an intrinsic role in the pathogenesis of PCOS (Goodman 2015). It is implicated in the ovulatory dysfunction of PCOS by disrupting the hypothalamic-pituitary ovarian axis. Hyperglycemia and its consequences are responsible for the effect of T2DM on reproductive health in women (Cretu 2020). IDDM women usually have delayed menarche and early menopause than non-diabetic women of their age, they can also be at risk of other menstrual issues like oligomenorrhea and amenorrhea which is due to effect on the Genotropin Releasing hormones (GnRH) Centre in the Hypothalamus which leads to diabetic menstrual dysfunction (Zarzylki 2005)

Glycemic control and prevention of diabetic complications improve these irregularities and increase fertility rate close to their counterpart (Livshit 2009). Some studies suggest that women with Diabetes Mellitus have higher testosterone and lower estradiol compared with other women without DM, high testosterone is related with increased insulin resistance, hyperinsulinemia, which increases the stimulation of the release of the increase androgen level which hinders the release of the sex hormone binding globulin, elevated level of progesterone in non- gravid, causes ovarian cysts, while in pregnancy causes gestational diabetes (Anna 2023).

Endocrine dysfunction causes imbalance in the hormone's secretion and action; imbalance in hormones like estradiol, testosterone and progesterone in a woman with DM affects the menstrual cycle, causes PCOS and infertility, Cortisol, a hormone produced by the adrenal glands every day to help the body cope with stress is also being affected; contributes to insulin resistance which otherwise causes hyperglycemia and its complication (Anna 2023).

Oxidative stress in women leads to damage to the DNA, which causes cell cycle arrest and cell death(apoptosis), thereby hindering development of egg follicles leading to anovulation and amenorrhea, thereby infertility (Zhou 2019). Obesity in women also causes infertility, it leads to insulin resistance, which causes hyperglycemia, disrupting the function of the hypothalamus leading to hormonal disorder, that eventually causes infertility (Pasquali 2006). Treatment strategies may vary depending on the type of diabetes and the individual's health condition, management of the disease is to maximize fertility; this includes

- regular exercise, which enhances glucose metabolism, dietary changes and monitoring of the blood sugar level (Lavin-Perez 2021).
- Insulin therapy may be needed depending on the type of diabetes. In type 1 diabetes insulin injection is the bedrock of treatment, T2 DM treatment includes dietary modification, oral medication, insulin may be prescribed (Raynolds2024).
- Weight loss through balanced diet and exercise can enhance hormonal balance and increase chances of conception (Lakoma 2023).
- Antioxidant supplementation can also help reduce oxidative damage to the reproductive cells caused by diabetes and improve fertility outcome in affected individuals and also boost sperm quality and health of the eggs (Bouhadana 2025).

African Chronicles Research Publication Journals p-ISSN 3121-8989, e-ISSN 3121-8970
Onianwa et al. (2026). Afr Chron Res Pub J, 3(3): 1 - 26
Article URL: https://researchpubjournals.org/post.php?post=1588
Public Health research – Supplement 1, Diabetes

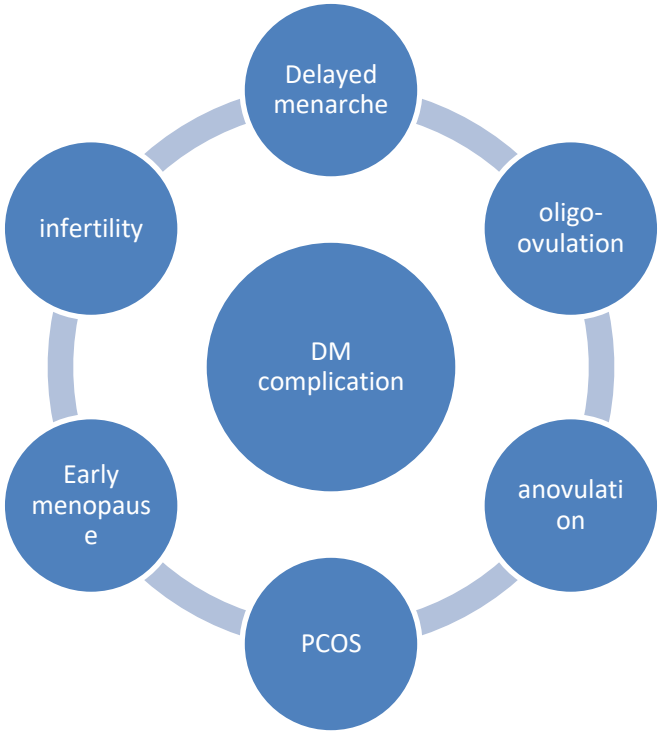


Fig 3: Reproductive dysfunction in women with Diabetes (Zaimi ,2024).

Diabetes mellitus is a complex chronic disease associated with reduced life expectancy, microvascular and macrovascular complications leading to reduced quality of life and thereby reduced life expectancy (Tomic 2022).

2.4: Epidemiology concepts of DM in infertility

Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations and the application of this study to the prevention and control of health problems (Hajat 2011). The father of epidemiology is John Snow. Components of epidemiology include disease frequency, distribution, and determinant.

Determinants of DM: This includes the risks factors of DM which include genetic, behavioral lifestyle, environmental factors and obesity (Jan 2017). Sedentary lifestyle: Reduced activity and exercise constitute a link with obesity and T_2DM, and high caloric diet; T2 DM can be prevented by improving the main modifiable risk factors (obesity, low physical activity and unhealthy diet)

(Garcia 2020). Lifestyle change plays important role in diabetes, which include maintaining a healthy body weight, eating a healthy diet, and staying physically active (Zheng 2017).

In global epidemic of DM, these three determinants are currently important: unhealthy diet, sedentary lifestyle and genetic predisposition (Zheng 2017). Insulin- resistance is often associated with obesity, physical inactivity and unhealthy diet, thereby they are three main modifiable factors in improving life expectancy on DM (Freeman 2023).

Obesity is an important risk factor in DM, also ageing, insulin resistance, stress. Behavioral contributions to DM include: lifestyle behaviors which include: dietary intake, lack of exercise, sedentary lifestyle, poor sleeping habits, stress (Donnas 2015). Stress affects food intake behaviors mostly causing craving for and consumption of high caloric foods: high in fat and sugars which can lead to obesity (Hill 2022).

In female: Tubal disorder e.g. tubal blockage due to PID thereby early detection and treatment of infection is very essential uterine disorder, hormonal disorder, lifestyle factors such as excessive smoking, excessive alcohol, ovarian disorder. Age is yet another factor: fertility declines with ageing (Garcia 2018). Tubal disorder: infections are a major cause of tubal factor in infertility (Despande 2019). The major cause of infertility in women is fallopian tube obstruction which is due to infection (Liu 2015). Hormonal disorder: this is due to disruption in hormonal function causing oligomenorrhoea, Amenorrhea, hyperprolactinemia (Zaimi 2024). Uterine factors include fibroid, uterine septum, congenital uterine abnormality, endometriosis (Adebisi 2025). Ovarian factor: ovarian cysts, ovarian tumor, ovulatory disorders (anovulation, oligo-ovulation) (WHO 2023).

In men: The causes of infertility include age, obstruction in reproductive tracts, hormonal disorder, genetics, testicular failure, abnormal sperm function, environmental lifestyle factors e.g. diet, smoking excessively, alcoholism, obesity, cultural behaviors, environmental toxin e.g. Pesticides, industrial radiation (WHO 2023, Uadia 2015, and Emakpai 2015). In the aga factor, fertility peaks and declines as age increases. In men fertility declines from 35 years, and after 40years of age semen DNA damages increase as well as poor sperm parameters (Uadia 2015, Vickram 2019)

2.5: Prevention and control of DM

Screening of at-risk group through glucose test will help early detection and prompt intervention which will reduce complication. Workshops and seminars should be organized to create more awareness of DM in the community, increase knowledge, positive attitude and good practice (KAP), thereby preventing its occurrence through dissemination of adequate information and control (Baig,2023).

Elimination of risk factors through lifestyle modifications e.g. trekking instead of using tricycle for short distances, dietary modification to avoid overweight and reduces obesity risks (Wadden,2020). Effective health education and counselling on the subject, is very important, will help individuals to make informed decisions, and improves knowledge, attitude and practices (Chawla 2019). Diabetic education is an essential tool in management of DM, dietary and physical activity interventions are very crucial in treatment of DM and its complications (Salma, 2023). Enactment of policies by policy makers on health e.g. restrictions on the use of tricycles which increase the possibilities of trekking; the policy thereby increases physical activity, promote health and increase prevention of DM for the high-risk citizens (Bergman 2012).

3: Conclusion

Diabetes is a metabolic disorder characterized by hyperglycemia which disrupts endocrine function leading to endocrine dysfunction, its complication includes retinopathy, neuropathy, cardiopathy and nephropathy with its macrovascular and microvascular effect. Adequate glycemic control will be of great positive effect on the affected. Early detection and adequate control will reduce the prevalence of infertility which is unplanned roadblock to parenthood with its psychological trauma caused by some cultural activities against infertile couples. The gap in knowledge and practice includes implication of hypertension (which mostly manifest in alignment with DM due to damage to blood vessels and nerves by high glycemia level) as a determinant factor in fertility. There is need for more extensive work to be done on it.

References

Adebisi OY, Singh M, Tobler KJ (2025). Female infertility. In: StatPearls (Internet). Treasure Island (FL): Statpearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK556033/

Agbaje IM, Rogers DA, McVicar CM, McClure N, Atkison AB, Mallidis C, Lewis S E M (2007). Insulin dependent diabetes mellitus: implications for male reproductive unction. Human Reproduction, 22(7),1871-1877. https://doi.org/10.1093/humrep/dem077

Agofure O, Okandeji-Barry OR, Ogbon, P (2020). Pattern of diabetes mellitus complications and co-morbidities in Ughelli LGA Delta State, Nigeria. *NJBCS* 17(2):123-127. doi:10.4103/njbcs.37-18

Agrawal A, Dave A, Jaiswal A (2023). Type 2 diabetes mellitus in patients with polycysticovarysyndrome. *Cureus,*15(10), e46859. https://doi.org/10.7759/cureus

American Diabetes Association (2018). Microvascular complications and foot care: standards of medical care in diabetics- 2018 *Diabetes Care.* **41(1):** S105-S118. doi:10.2337/dc18-S010

Anna G (2023). Causes of infertility in women with Diabetes; Literature Review. *Int. J. of Clin. Case Rep. Rev.*14(04):01-07. doi:10.31579/2690-4861/334

Azziz R, Carmina E, Dewailly D, Diamanti-Kandarakis E, Escobar-Moreale HF, Futterweit W, Janssen OE, Legro RS, Norman RJ, Taylor AE, Witchel SF (2009): Task force on the phenotype of the Polycystic ovary Syndrome of the androgen excess and PCOS society. The Androgen excess and PCOS Society criteria for polycystic ovary syndrome. the complete task force report. *Fertil Steril* 91(2):456-88. doi: 10.1016/j.fertnstert.2008.06.035

Badejogbin OC, Chijioke- Agu OE, Olubiyi MV, Agunloye MO (2024) pathogenesis of testicular dysfunction in diabetes: exploring the mechanism therapeutic interventions. *J Assist Reprod Genet*.42(2):367-376. doi:10.1007s10815-024-03314-3

Baig M, Alzahrani S, Abualhamael S, Alotaibi A, Alharbi M, Almohammadi T, Alkaabi T (2023). Diabetes mellitus knowledge, attitudes, preventive practices and associated factors among a sample of adult non-diabetic Saudi residents. *Diabetes, Metab Syndr and obes: targets and therapy*, 16,1393-1406. https://doi.org/10.2147/DMSO.s409330

Banday MZ, Sameer AS, Nissar S (2020). Pathophysiology of diabetes; An overview. *Avicenna J. Med* 10(4),174-188. https://doi.org/10.4103/ajm.ajm-53-20

Bergman M, Buysschaert M, Schwarz P E, Albright A, Narayan KV, Yach D (2012). Diabetes prevention; global health policy and perspectives from the ground. *Diabetes Manag (London,England)*,2(4),309-321. https://doi.org/10.2217/dmt.12.34

Bernier A, Fung J, Ergun- Longmire B (2022.). A narrative review; polycystic ovary syndrome (PCOS) and type 1 diabetes. *Pediatr Med*.6 https://dx.doi.org/10.21037/pm-22-3

Bouhadana D, Godin Page MH, Montjean D, Belanger MC, Benkhalifa M, Miron P, Petrella F (2025). The role of antioxidants in male fertility: A comprehensive Review of Mechanisms and clinical applications. *Antioxidants (Basel).*14(8):1013. doi:10.3390/antiox14081013

Burnett Al (2007). The role of nitric oxide in erectile dysfunction: implications for medical therapy. *J Clin Hypertens* .8(12):53-62. doi:10.1111/j.1524-6175.2006. 06026.x

Carson SA, Kallen A N (2021). Diagnosis and management of infertility: A review. JAMA, 326(1), 65-76. https://doi.org/10.1001/jama.2021.478

Carrizzo A, Izzo, C, Olivet M, Alfano A, Virtuoso N, Capunzo M, De Simone E Sciarretta S, Frati G Migliarino S Damato A, Ambrosio M, De Caro, Vecchione C (2018). The main determinants of diabetes mellitus vascular complications. Endothelial Dysfunction and platelet Hyperaggregation *Int J mol Sci.***19**(10): 2968. doi:10.3390/ijms.1mfs9102968

Chandrasekaran P, Weiskirchin R (2024). The role of obesity in Type 2 diabetes Mellitus _an overview. *Int J Mol Sci* 25(3):1882. doi:10.3390/ijms25031882

Chawla A, Chawla R, Jaggi S (2026). Microvascular and macrovascular complications in diabetes mellitus: Distinct or continuum? *Indian J endocrinol metab*, 20(4), 546-551. https://doi.org/10.4103/2230-8210.183480

Chawla S P S, Kaur S, Bharti A Garg R, Kaur M Soin D, Ghosh A, Pal R (2019). Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus. *J Family Med Prim Care*, 8(1), 261-268. https://doi.org/10.4103/jfmpc.jfmpc-228-18

Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG. Blissmer BJ, Rubin RR, Chasan-Taber L, Albright AL, Braun B (2010). Exercise and type 2 diabetes: The American College of Sports, Medicine and the American Diabetes Association: joint position statement. *Diabetes Care.***33**(12): e147-67 doi:10.2337/dc10-99990

Cretu D, Cernea S, Onea CR, Pop RM, (2020): Reproductive health in women with type2 Diabetes Mellitus. *Hormones (Athens)*.19(3):291-300. doi:10.1007/s42000-020-00225-7

Daltijo M, Andreadis N, Aminu B, Umar N, Black KI (2016); The prevalence and clinical pattern of infertility in Bauchi, northern Nigeria. *Trop J Obstet Gynaecol*. 33(1)76-85. https://doi.org/10.4103/0189-5117.192224

Deshpande PS, Gupta AS (2019). Causes and prevalence of factors causing infertility in a public health facility. *J Hum Reprod Sci*12(4):287-293. doi:10.4103/jhrs. JHRS- 140 – 18

Dimitriadis GD, Maratou E, Kountouri A, Board M, Lambadiari V (2021); Regulation of postabsorptive and postprandial glucose metabolism by insulin-.115&**Nuttrients*.13(1):159. doi.10.3390/nu13010159

Ding G, Liu M, Pam J, Pan J, Guo M, Sheng J, Huang H (2015); the effect of diabetes on male fertility and epigenetic regulation during spermatogenesis. *Asian J Androl.* 17(6):948-53. doi:10.4103/1008-682X.150844

Eze U, Ezeh C, Pisarska MD, Azziz R (2021) Menstrual dysfunction in polycystic ovary syndrome; association with dynamic state in insulin resistance rather than hyperandrogenism. *Fertil Steril.*15(6):1557-1568 doi;10.1016/j. fertnstert.2020

Ezeh U, Pisarka MD, Azziz R (2022): Association of severity of menstrual dysfunction with hyperinsulinemia and dysglycemia in polycystic ovary syndrome. *Hum Reprod.*37(3):553-56 doi:10.1093/humrep/deac001

Farmaki P, Damaskos C, Garmpis N, Garmpi A, Savvanis S, Diamantis E (2020); Complications of the type 2 diabetes Mellitus. *Curr Cardiol Rev.*16(4):249-251. doi;10.2174/1573403X1604201229115531

Fatima W, Akhtar A, Hanif A, Gilani A, Farooq S (2024). Comparison of baseline, sociodemographic and gynecological risk factors associated with secondary infertility of females in Pakistan. *Womens Health Rep*. 5(1):340-345. doi:10.1089/whr.2023.0145

Freeman AM, Acevedo LA, Pennings N (2023); Insulin resistance. In:StatPearls (internet). Treasure Island (FL): Stat Pearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK507839/

Garcia D, Brazal S, Rodriguez A, Prat A, Vassena R, (2018) Knowledge of age- related fertility declines in women; A systematic review. *Eur J Obstet Gynecol Reprod Biol*.230:109-118. doi: 10.1016/j.ejogrb.2018.09.030

Garcia-Garcia U, Benito- Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martin C (2020) Pathophysiology of Type 2 diabetes mellitus. *Int J Mol Sci*. 21(17):6275. Doi:103390/ijms21176275

Good to know: Diabetes Symptoms and Tests (2020). 38(1):108 *Clin Diabetes* https://doi.org/10.2337/cd20pe01

Goodman N, et al (2015) American association of clinical endocrinologists, American college of endocrinology, and Androgen excess an PCOS society Disease state clinical review: Guild to the best practice in the evaluation and treatment of PCOS-PART 1. *Endocr Pract*. 21(11):1291-300. doi:10.4158/EP15748. DSC

Gottwald-Hostalek U, Gwilt M (2022). Vascular complications in prediabetes and type 2 diabetes: a continuous process arising from a common pathology. Curr *Med Res Opin*38(11):1841-1851. https://doi.org/10.1080/03007995.22.2101805

Goyal S, Rani J, Bhat M A, Vanita V (2023). Genetics of diabetes. *World J Diabetes*, 14(6),656-679. https://doi.org/10.4239/wjd.v14

Hackett G, Kirby M, Rees R W, Jones T H, Muneer A, Livingston M, Ossei-Gerning N, David J, Foster J, kalra P A, Ramachandran S (2023). The British Society for Sexual Medicine guidelines on male adult testosterone deficiency with statement for practice. The world Journal of Men's Health, 41(3), 508-537. https://doi.org/10.5534/wjmh.221027

Hajat C (2011). An introduction to epidemiology. *Methods Mol Bio*.713:27-39. doi:10.1007/978-1-60327-416- 6-3.

Hall J, Hall M, Guyton and Hall (2017); Guyton and Hall Textbook: Test Medical physiology. *Surg Neurol Int*.8:275. doi: 10.4103/sni.sni-327-17

He Z, Yin G, Li QQ, Zeng Q, Duan J (2021): Diabetes Mellitus causes male reproductive dysfunction. A review of the evidence and mechanism. *In Vivo*.35(5):2503-2511. doi:10. 21873/invivo.12531

Hill D, Conner M, Clancy F, Moss R, Wilding S, Bristow M, O Connor DB (2022). Stress and eating behaviors in healthy adults; a systematic review and meta-analysis. *Health Psychol Rev*.16(2):280-304. Doi.1080/17437199. 2021..1923406

Hostnik B, Tonin G, Jane A, Klen J (2025). Erectile dysfunction in diabetes mellitus; A comprehensive narrative review of pathophysiology, Genetic association studies and therapeutic approaches. *Endocrinol Diabetes metab*, (5), e70099. https://doi.org/10.1002/edm2.7009

Guo H, Wu W, Li Z (2023). The Pathogenesis of diabetes. *Int J of Mol Sci* **24**(8):69-78. doi:10.3390/ijms24086978

Huang R, Chen J, Guo B, Jiang C, Sun W (2024): Diabetes induced male infertility; potential mechanism and treatment options. *Mol Med*.30(1):11. doi:10.1186/s10020-023- 00771-x

Jan A, Khan A, Khan S, Khan M (2017): Causes, complication and management of DM. *Chron J Food Nutr.*, 1(1):002

Jacobsen L M, Schatz D A(2026). Type 1 Diabetes: A Review. JAMA, 335(12), 1070-1083. https://doi.org/10.1001/jama.2026.0048

Joseph J J, Golden SH, (2016). Cortisol dysregulation; the bidirectional link between stress, depression and type 2 diabetes mellitus. *Ann N Y Acad Sci*.1391(1):20-34. doi:10.1111/nyas.13217

Kouidrat Y, Pizzol D, Cosco T, Thompson T, Carnaghi M, Bertoldo A, Solmi M, Stubbs B, Veronese N (2017): High prevalence of erectile dysfunction in diabetes: a systematic review and meta-analysis of 145 studies. *Diabet Med*. 34(9):1185-1192. oi:10.1111/dme.13403

Lakoma K, Kukharuk O, Sliz D (2023). The influence of metabolic factors and diet on fertility. *Nutrients*, 15(5), 1180. https://doi.org/10.3390/nu15051180

La Vignera S, Condorelli R, Vicari E, D'Agata R, Calogero AE (2012). Diabetes mellitus and sperm parameters. *J Andr*ol.33(2):145-53. oi:10.2164/jandrol.111.013193

Leslie S W, Soon-Sutton T L, Khan M A B, (2026). Male infertility.in:Statpearls (internet).TreasureIsland(FL):Statpearls. https://www.ncbi.nlm.nih.gov/books/NBK562258/?utm_source=chat.com

Liu J, Qin Y, Liu H, Liu Y, Yang Y, Ning Y, Ye H (2025). Global regional and national burden of female infertility and trends from 1990 to 2021 with projections to 2050 based on the GBD 2021 analysis. Sci Rep https://doi.org/10.1038/s41598-025-01498-x

Liu R, Li l, Shao C, Cai H, Wang Z (2022). The impact of diabetes on vascular disease: Progress from the perspective of epidermic and treatments. *J. Diabetes Res,*2022,1531289. https://doi.org/10.1155/2022/153

Long L, Qiu H, Cai B, Chen N, Tio fang L, Zhang Xiaoxin Y, Li Y (2018) Hyperglycemia induced testicular damage in type 2 DM rats exhibiting microcirculation impairments associated with vascular endothelial growth factor decreased viap13K/Akt pathway. *Oncotarget.* 9(4);5321-5336. doi:10.18632/oncotarget.23915

Maresch CC, Stute DC, Alves Mg, Oliveira PF, Kretser DM, Linn T (2018): Diabetes- induced hyperglycemia impairs male reproductive function: a systematic review. Hum Reprod.24(1):86-105. doi:10.1093/humupd/dmx033

Murea M, Ma L, Freedman BI (2012). Genetic and environmental factors associated with type 2 diabetes diabetic vascular complications. The review of diabetic studies: RDS, 9(1,6-22). Https://doi.org/10.1900/RDS.2012

Odunvbun W, Oziga D, Oyeye L, Ojeogwo C (2025); Pattern of infertility among infertile couple in a secondary health facility in Delta state, south- south Nigeria. Trop J Obstet Gyneacol.35(3):244. doi: 10.4103/TJOG.TJOG-61-18

Oduwole O O, Huhtaniemi M M (2021). The role of Luteinizing hormone, follicle stimulating hormone and testosterone in spermatogenesis and folliculogenesis. Int J Mol Sci,22 (23),12735. https://doi.org/10.3390/ijms2223

Ojo OA, Ibrahim HS, Rotimi DE, Ogunlakin AD, Ojo AB (2023) Diabetes mellitus: from molecular mechanism to pathophysiology and pharmacology. Medicine inNovelTechnologyandDevices.Vol.19 https://doi.org/10.1016/j.medntd.2023.100247

Olamoyegun MA, Alare K,Afolabi SA (2024). A systematic review and meta-analysis of the prevalence and risk factors of type 2 diabetes mellitus in Nigeria.*Clin Diabetes Endocrinol 10,43*. https://doi.org/10.1186/s40842-024-00209-1

Pasquali R, (2006). Obesity, fat distribution and infertility. *Maturitas*.54(4):363-71. doi: 10.1016/j.maturitas.2006.04.018

Patel P, Abate N (2013). Body fat distribution and insulin resistance. *Nutrients*, 5, (6). 2019 -2027 https://doi.org/10.3390/nu50620

Lavin-Perez A, Mateo D, Villafains Guisado S, V, (2021); The role of exercise to reduce the impact of Diabetes in seminal quality; a systematic review. *Medicina*.57(2):159. oi:10.3390/medicina57020159

Rahman MS, Hossain KS, Das S, Kundu S, Adegoke EO, Rahman M A, Hannan MA, Uddin MJ, Pang MG (2021). Role of insulin in health and disease: An update of Int. J. Mol. Sci. 22(12),6403

Rask-Madsen C, King G L (2013). Vascular complications of diseases: mechanisms of injury and protective factors. Cell metabolism,17(1),20-33, https://doi.org/10.1016/j.cmt

Reynolds A, Mitri J (2024). Dietary advice for individuals with diabetes. In: FeingoldKR,AdlerRAAhmed SF.https://www.ncbi.nlm.nih.gov/books/NBK279012/

Islam k, Islam R, Nguyen I, Malik H, Pirzadah H, Shrestha B, Lentz IB, Shekoohi S, Kaye AD (2025): Diabetes Mellitus and Associated vascular disease: pathogenesis, complications and evolving treatments. *Adv ther.*42(6):2659-2678. doi:10.1007/s12325-025-03185-9

Sakumoto T, Tokunaga Y, Tanaka H, Nohara M, Motegi E, Shinkawa T, Nakaza A, Higashi M (2010). Insulin resistance /hyperinsulinemia and reproductive disorders in women, *Reprod Med biol*, 9(4), 185-190. https://doi.org/10.1007/s12522-010-0062-5

Salama I I, Sami SM, Salma SI, Abdel-Latif G A, Aboulghate A, Raslan HM, Mohsen A, Rasmy H, Ibrahim MH, Ganem MM, Abdelmohsen AM, El-Etreby L A, Ibrahim NA, Fouad WA, El-Deeb SE (2023). Impact of lifestyle modification on glycemic control and cognitive function among type 2 diabetes mellitus patients. *Future Sci OA,* 9(1), FS0835 https://doi.org/10.2144/fsoa-2022-0060

Shukia A, Rasquin LI,Anastasopoulou C(2025) . Polycystic ovarian syndrome. In:StatPearls(Intrenet).Treasure Island(FL):StatPearls Publishing.

Smith AD, Crippa A, Woodcock J, Brage S (2016). Physical activity and incident type 2 diabetes mellitus: a systematic review and dose-response meta-analysis of prospective cohort studies. *Diabetol*ogia. 59(12): 2527- 2545. doi:10.1007/s00125-016-4079-0.

Spruilt-Metz D, Cook L,O Reilly G,Page K, Quinn C (2014). Behavioural contribution to the pathogenesis of type 2 Diabetes.*Curr Diab Rep* 14(4) :475 doi:10.1007/s11892-014-0475-3

Tabak AG, Herder C, Rathmann W, Brunner EJ, Kivimaki M (2012). Prediabetes: a high -risk state for diabetes development. Lancer (London, England),379(9833),2279-2290. https://doi.org/10.1016/S01406736(12)60283-9

Tamas V, Kempler P (2014): Sexual dysfunction in diabetes. *Handb Clin Neurol*.126:223-32. doi:10.1016/B978-0-444-53480-4.00017-5

Tomic D, Shaw JE, Magliano DJ (2022); The burden and risk of emerging complications of diabetes mellitus. *Nat Rev Endocrinol*.18(9):525-539.doi:10.1038/s41574-022-00690-7

Uadia P, Emokpae, A. (2015). Male infertility in Nigeria, A neglected reproductive health issue requiring attention. *Journal of Basic and clinical Reproductive Sciences.* 4(2): doi;10.4103/2278-960x.161042.

Uloko AE, Musa BM, Ramalan MA, Gezawa ID, Puepet FH, Uloko AT, Borodo MM, Sada KB (2018). Prevalence and factors for diabetes mellitus in Nigeria: A systematic review and meta- analysis. Diabetes Therapy,9(3),1307-1316. https://doi.org/10.1007/s13300-018-0441-1

Vickram AS, Dhama K, Chakraborty S, Samad HA, Khurana SK, Tiwari R, Bhatt P, Chaicumpa W (2019). Role of anti-sperm antibodies in infertility, pregnancy and potential for contraceptive and antifertility vaccine designs: Research progress and pioneering Vision. *Vaccines,* 7(3), 116. https://doi.org/10.3390/vaccines7030116

Wadden T A, Tronieri J S, Butryn M L (2020). Lifestyle modification approaches for the treatment of obesity in adults. *Am Psychol*, 75(2), 235-251. https://doi.org/10.1037/amp0000517

Wolfs MGM, Hofker MH, Wijmenga C, van Haeften TW (2009); Diabetes Mellitus: New Genetic Insights will lead too New Therapeutics. MM, Sda *Curr Genomics*.10(2):110-118. doi:10.2174/138920209787847023

World Health Organization (2023). 1 in 6 people globally affected by infertility. https://www.who.int/ews/item/04-4-2023-1-in-6-people-globally-affected-by-infertility

World Health Organization (2025). Infertility. https://www.who.int

Zaimi M, Michalopoulou O, Stefanaki K, Kazakou P, Vasileiou V, Psaltopoulou T, Karagiannakis D S, Paschou S A (2024). Gonadal dysfunction in women with diabetes. Endocrine, 85(2),461-472. https://doi.org/10.1007/s12020-024-03729-z

Zarzycki W, Zieniewicz M (2005): Reproductive disturbance in type 1 diabetic women. *Neuro Endocrinol* Lett.26(6):733-8. PMID:16380672